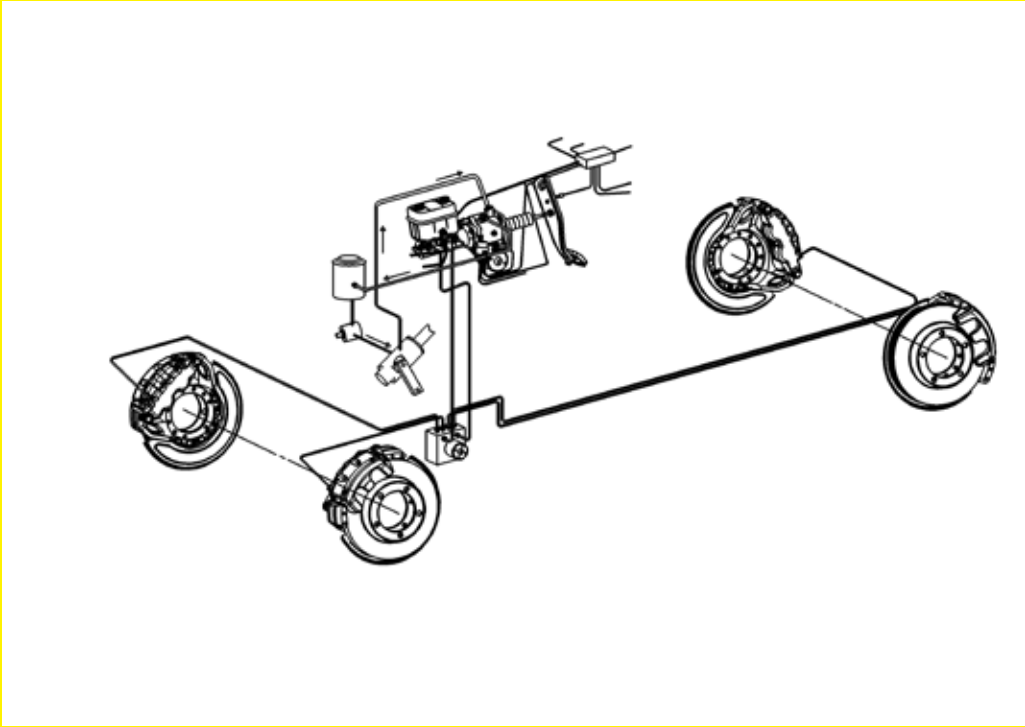
Class 5 to 7 Truck and Bus Hydraulic Brake System



Diagnostic Guide
2nd Edition

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Important Service Notes

The information in this publication was current at the time of printing. The information presented in this publication is subject to change without notice or liability.

The information contained in this publication is intended for use by properly trained and equipped professional technicians and is NOT for the “Do It Yourselfer.”

Failure to follow safety and repair procedures can result in personal injury, or damage to vehicles, components and equipment.

⚠WARNING

Failure to follow safety and vehicle repair procedures either contained in this manual, in the chassis and vehicle manufacturer’s repair manuals or in accordance with other accepted methods can result in personal injury, death, or damage to components, vehicles, or personal property.

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Preface

Purpose of This Diagnostic Guide

The purpose of this diagnostic guide is to assist Class 5 to 7 hydraulic brake repair technicians to more accurately and quickly diagnose the most likely causes of a customer's brake related complaint.

This diagnostic guide is NOT a repair instruction, but only a guide. When the probable cause of a customer's complaint is established, the repair procedure must be done in accordance with the instructions in the vehicle manufacturer's service manual.

Using This Diagnostic Guide

The brake technician must be able to understand the customer's complaints and description of the symptoms well enough to match them to one (or more) of the categories listed in the **Table of Contents**. Most customer complaints and symptoms on the vehicle can be matched to these categories. Each category has a corresponding flow chart that will lead the brake technician to the most likely cause of the customer's complaints and vehicle symptoms.

IMPORTANT REMINDER: The first step in diagnosing any customer complaint is to confirm the customer's complaint and determine which category applies.

The flow charts show which diagnostic steps need to be taken. The brake technician must have the necessary skills needed to perform each step. The flow charts are structured to guide the brake technician to take the quickest and easiest steps first. Often, these first, simple steps will be enough to determine what repair needs to be made.

⚠WARNING

After completion of all diagnostic steps, the brake technician must remember to tighten any tube nuts, fittings, bolts, screws, bleeder screws, etc., that were loosened as part of the diagnostic procedure.

In all cases, the vehicle manufacturer's service manual must be used for any repair instructions.

Brake system warning lights and buzzers are unique to the vehicle manufacturer. The **Brake Warning Light and Buzzer Do Not Shut Off** flow chart offered in this guide is generic and may not apply to all vehicles. The vehicle manufacturer's service manual must be consulted in order to determine the proper function of these warning devices.

Exclusions

The ABS portion of the hydraulic brake system is not addressed in detail in this guide since the ABS hardware and software are unique to the specific vehicle manufacturer. Any diagnosis or repair needs to be done in accordance with the vehicle manufacturer's ABS service manual.

Hydraulic Brake System Diagram

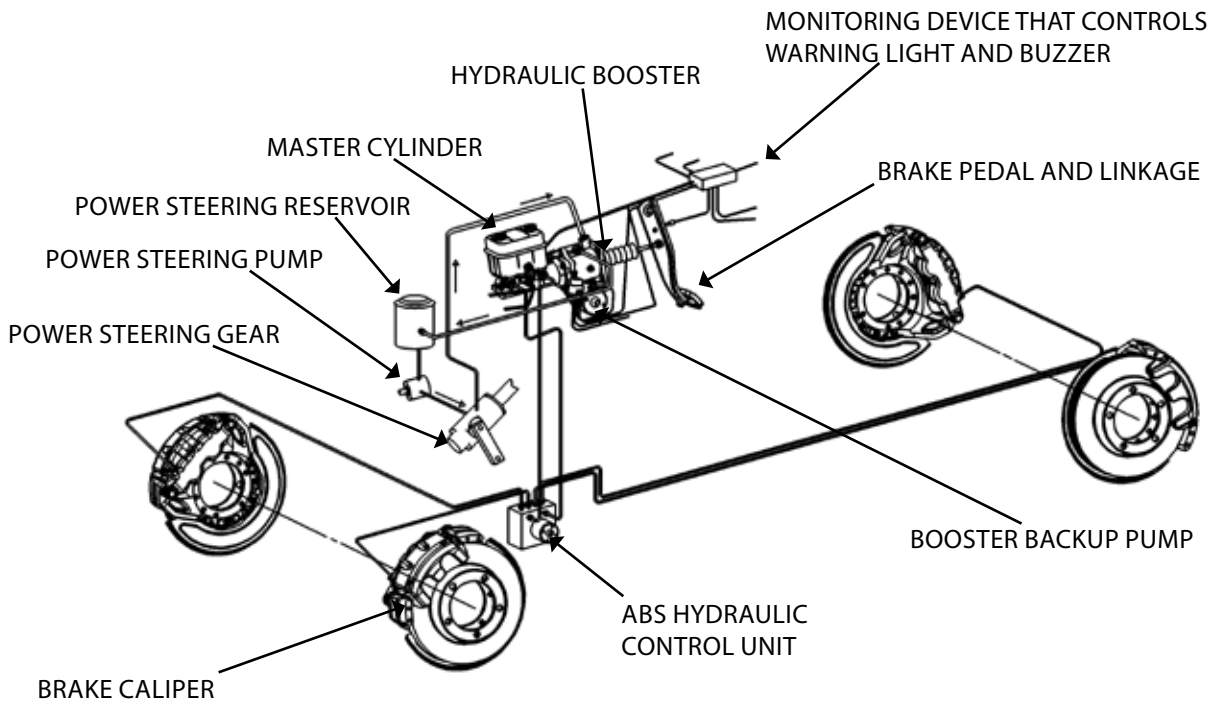


Figure 1. Brake System Components

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Schematic of Typical Electrical System

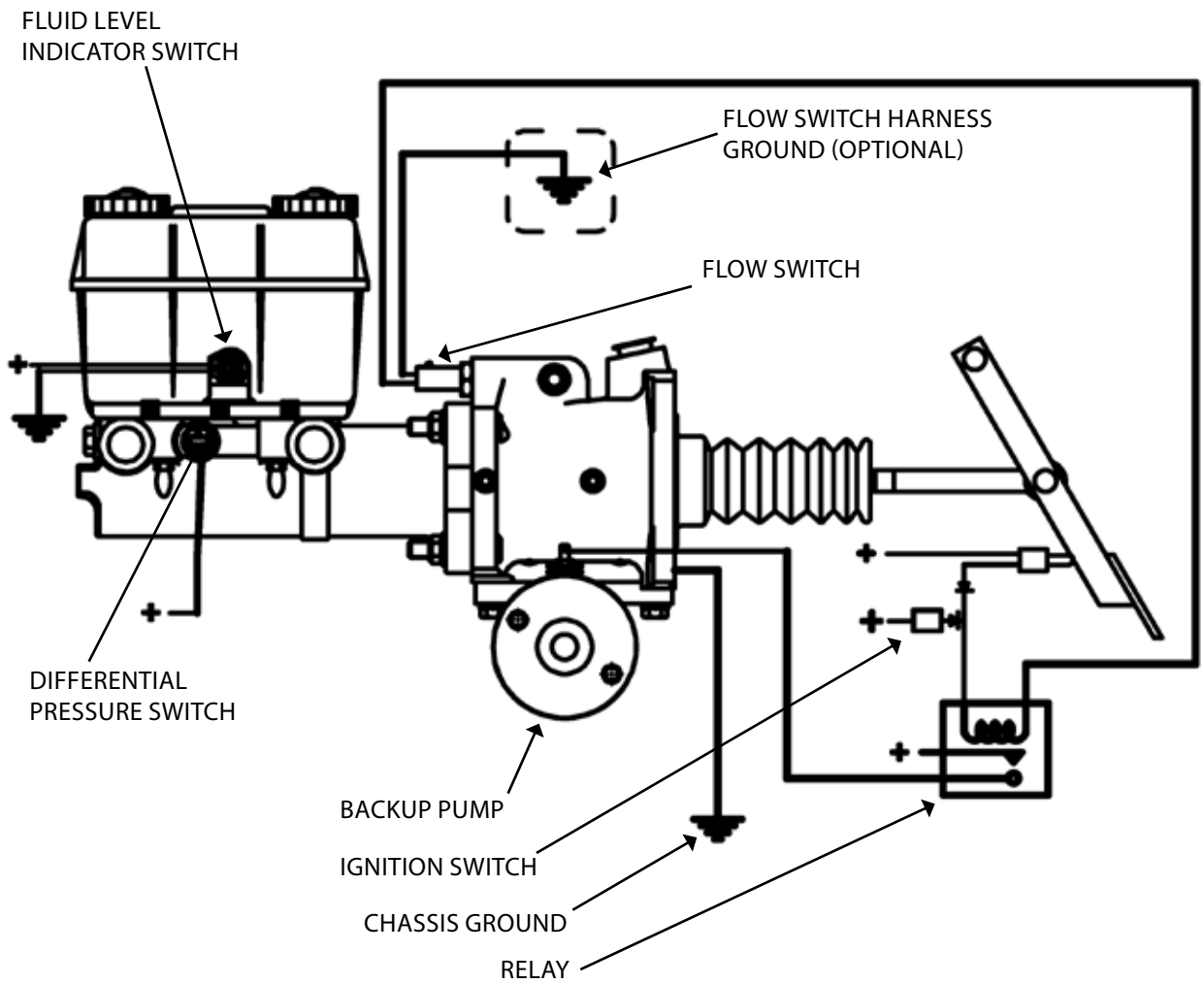


Figure 2. Schematic of Typical Electrical System

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Potential Master Cylinder and Booster Leak Points

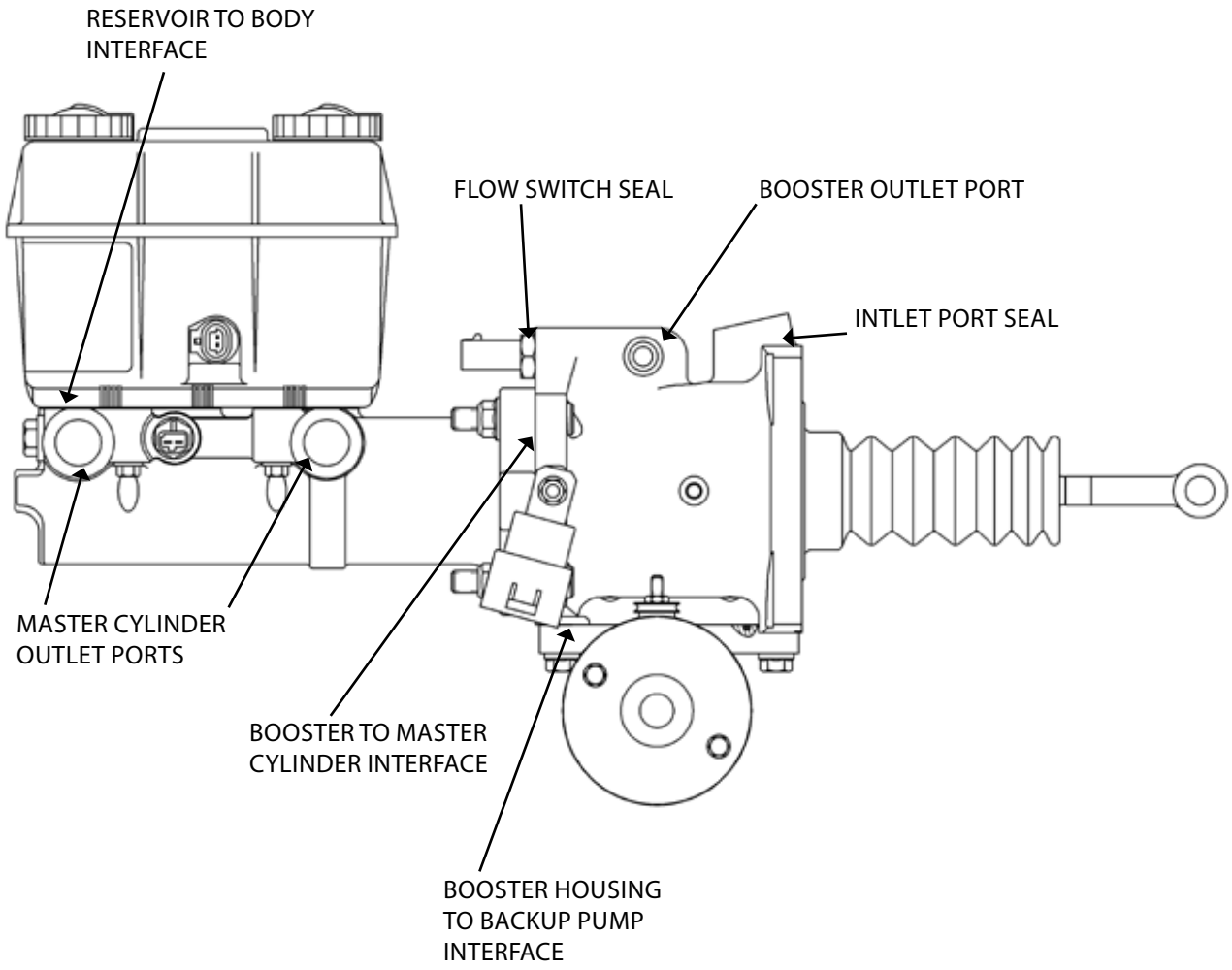
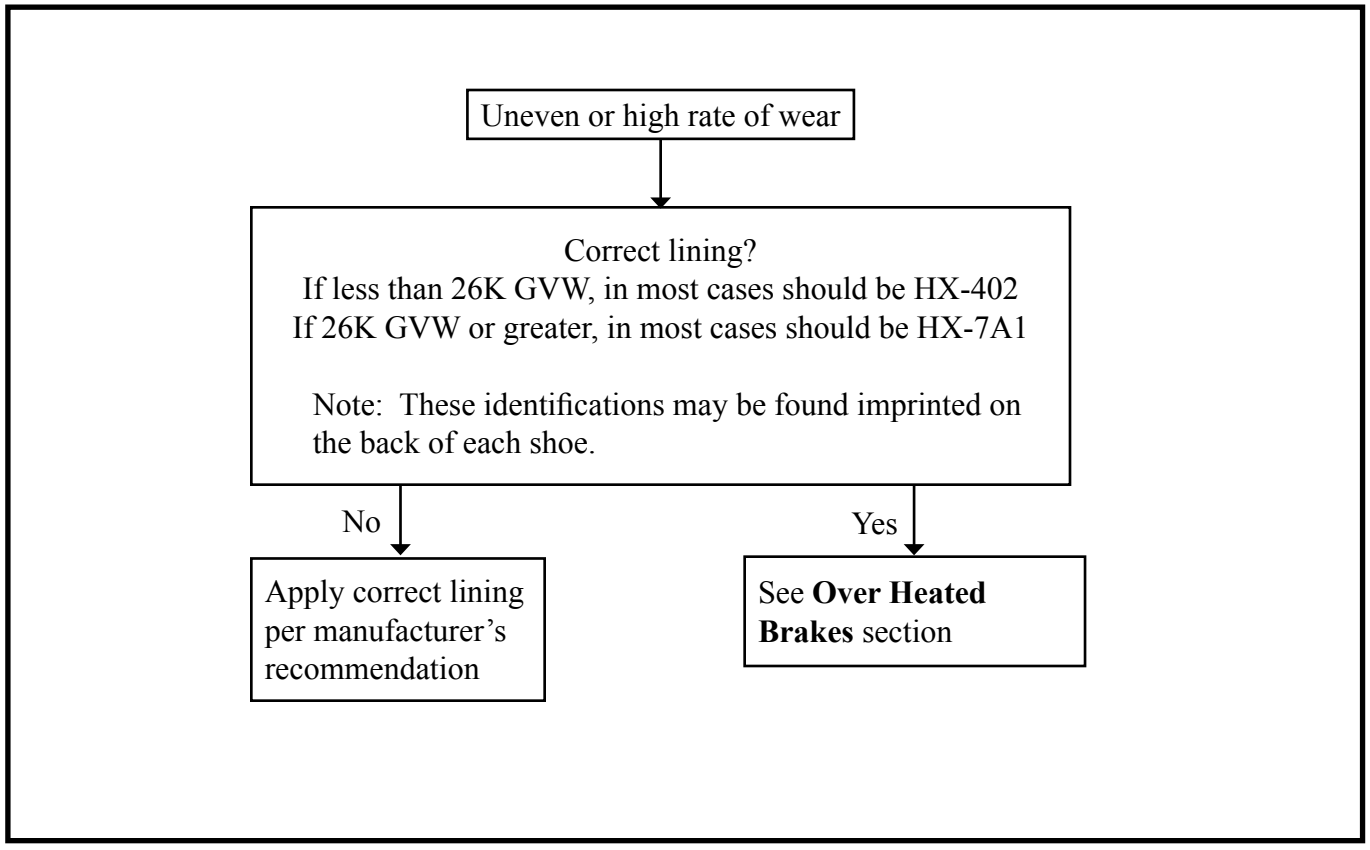

RESERVOIR TO BODY INTERFACE
FLOW SWITCH SEAL
BOOSTER OUTLET PORT
INTLET PORT SEAL
MASTER CYLINDER OUTLET PORTS
BOOSTER TO MASTER CYLINDER INTERFACE
BOOSTER HOUSING TO BACKUP PUMP INTERFACE

Figure 3. Potential Master Cylinder and Booster Leak Points

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Low Shoe Pad Life or Uneven Shoe Pad Wear

Uneven lining wear or rapid lining wear is often mistaken as stuck calipers. More probable root causes are incorrect linings, excessive brake duty, or incorrect repairs when last serviced. See back of lining for lining type.


Uneven or high rate of wear
Correct lining?
If less than 26K GVW, in most cases should be HX-402
If 26K GVW or greater, in most cases should be HX-7A1
Note: These identifications may be found imprinted on the back of each shoe.
No
Yes
Apply correct lining per manufacturer's recommendation
See **Over Heated Brakes** section

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Over Heated Brakes

Typical over heated brake signs and symptoms may include brake lining odor, steering wheel pull, or blued rotors.

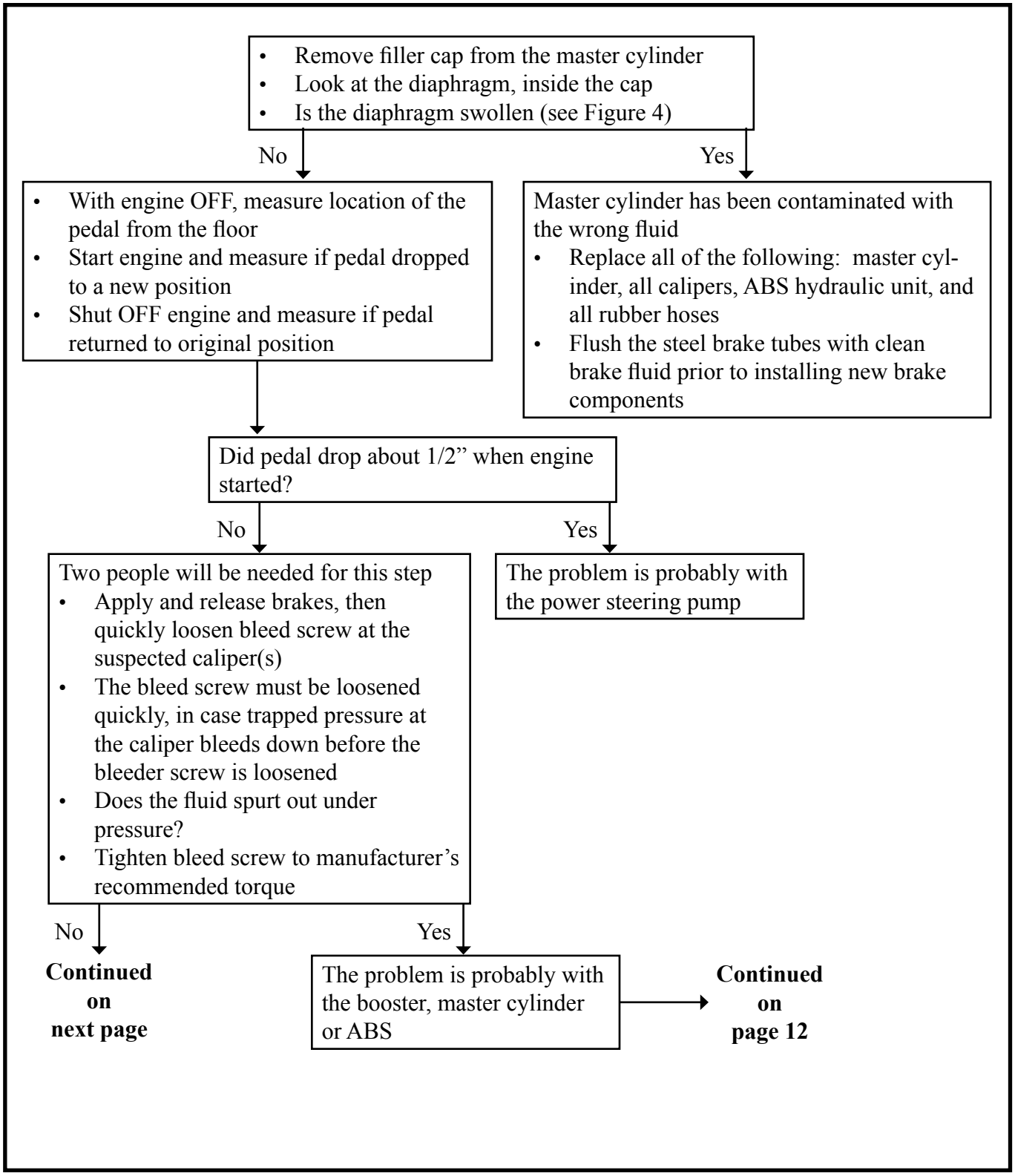
Uneven lining wear or rapid lining wear is often mistaken as stuck calipers. More probable root causes are incorrect linings, excessive brake duty, or incorrect repairs when last serviced. (See page 8 Low Shoe Pad Life or Uneven Shoe Pad Wear.)

Possible causes of over heated brakes:

1) Booster does not return
2) Brake pedal does not return
3) Brake hoses and tubes collapsed or kinked
4) Master cylinder does not return
5) ABS traps pressure
6) Brake caliper does not release.
7) There are two different guide pins that connect the anchor plate to the caliper. Verify proper assembly per manufacturer's recommended procedure.
8) Improper brake operation may be due to caliper interference with adjacent truck components as the caliper moves inboard, as linings wear. Verify that there is no interference.

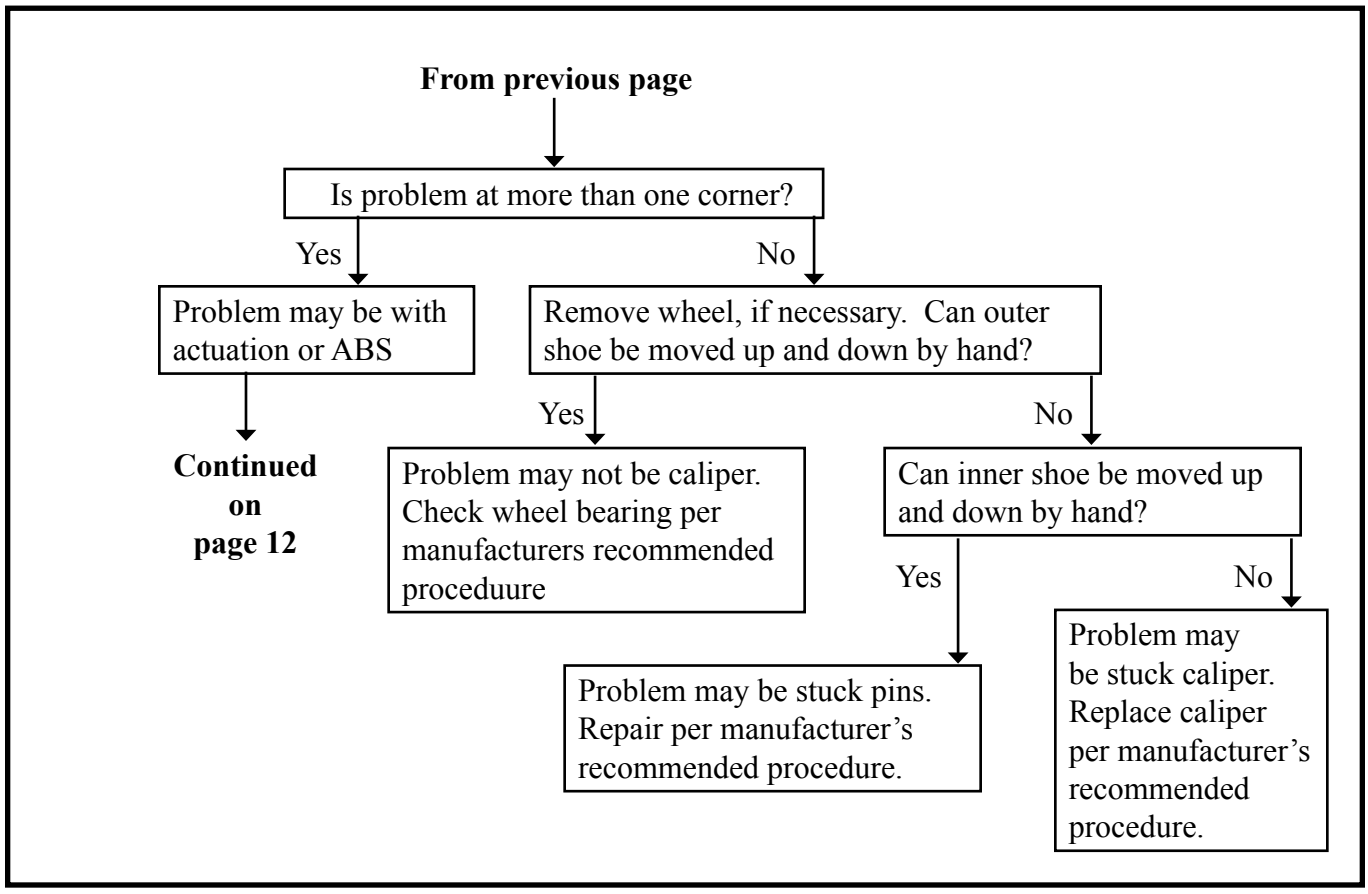
NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Over Heated Brakes (continued)


• Remove filler cap from the master cylinder
• Look at the diaphragm, inside the cap
• Is the diaphragm swollen (see Figure 4)
No
Yes
• With engine OFF, measure location of the pedal from the floor
• Start engine and measure if pedal dropped to a new position
• Shut OFF engine and measure if pedal returned to original position
Master cylinder has been contaminated with the wrong fluid
• Replace all of the following: master cylinder, all calipers, ABS hydraulic unit, and all rubber hoses
• Flush the steel brake tubes with clean brake fluid prior to installing new brake components
Did pedal drop about 1/2" when engine started?
No
Yes
Two people will be needed for this step
• Apply and release brakes, then quickly loosen bleed screw at the suspected caliper(s)
• The bleed screw must be loosened quickly, in case trapped pressure at the caliper bleeds down before the bleeder screw is loosened
• Does the fluid spurt out under pressure?
• Tighten bleed screw to manufacturer's recommended torque
The problem is probably with the power steering pump
No
Yes
Continued on next page
The problem is probably with the booster, master cylinder or ABS
Continued on page 12

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

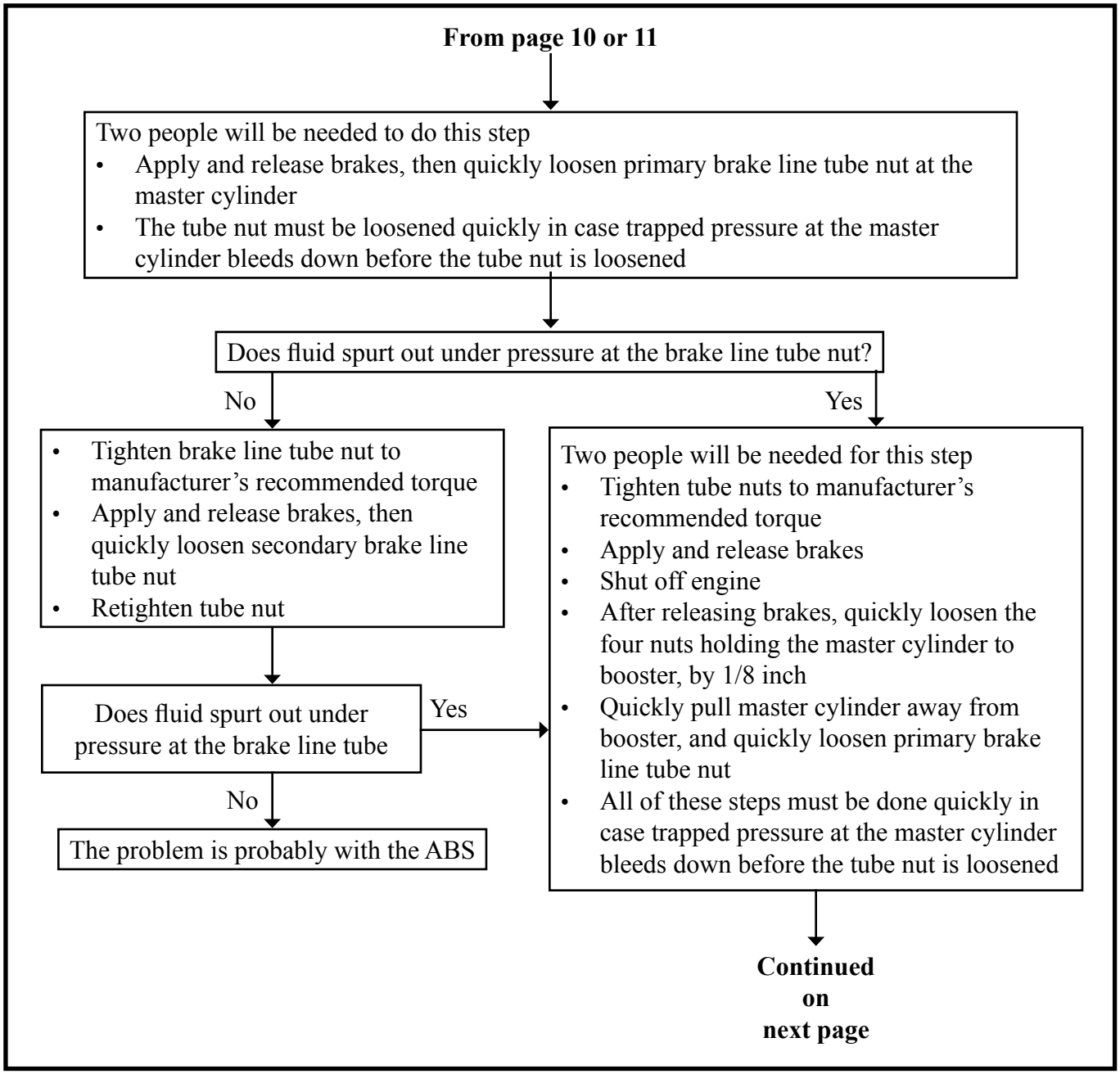
Over Heated Brakes (continued)


From previous page
Is problem at more than one corner?
Yes
No
Problem may be with actuation or ABS
Remove wheel, if necessary. Can outer shoe be moved up and down by hand?
Continued on page 12
Yes
No
Problem may not be caliper. Check wheel bearing per manufacturers recommended proceduure
Can inner shoe be moved up and down by hand?
Yes
No
Problem may be stuck pins. Repair per manufacturer's recommended procedure.
Problem may be stuck caliper. Replace caliper per manufacturer's recommended procedure.

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

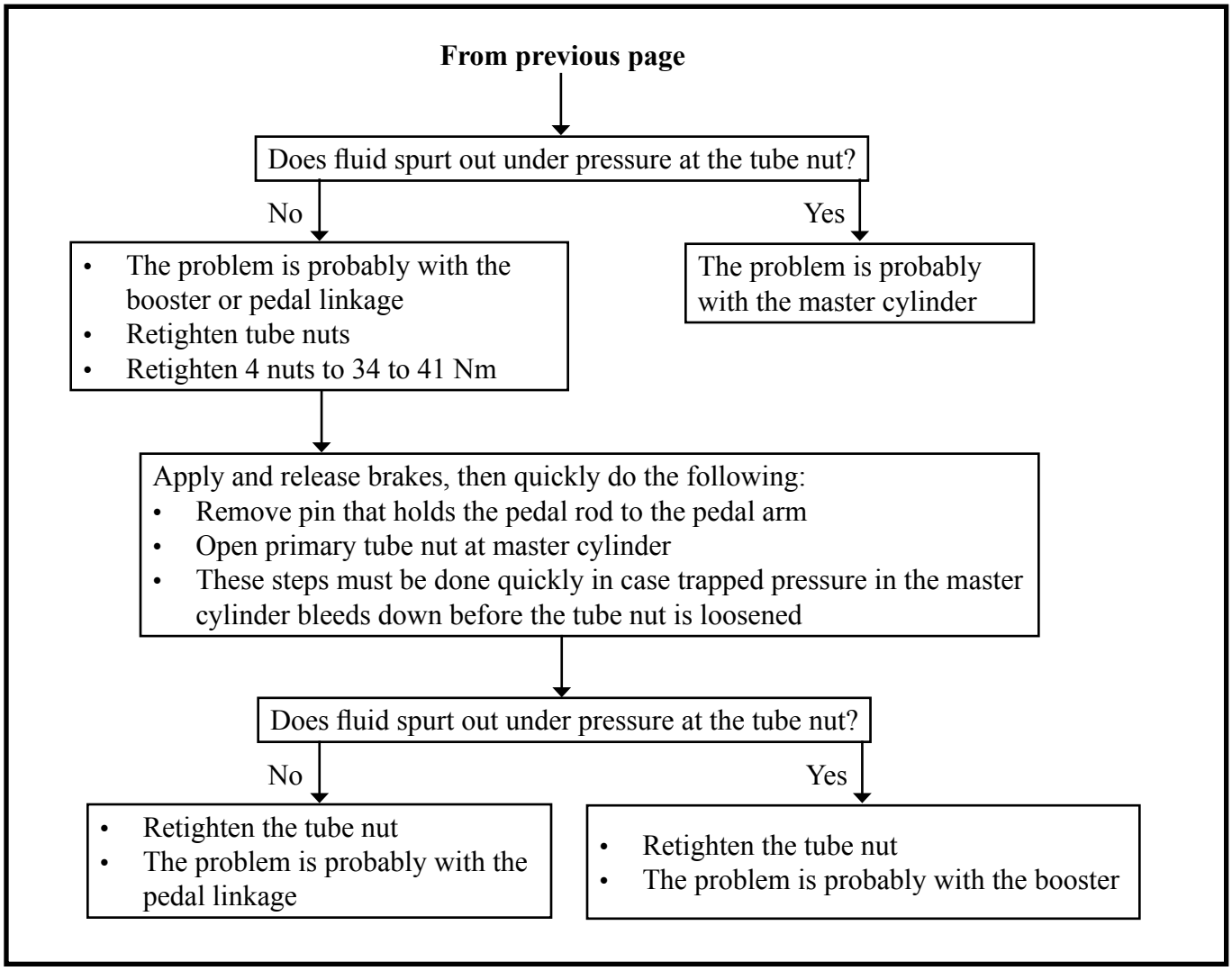
Over Heated Brakes (continued)

Prior to moving master cylinder 1/8 inch away from booster, loosen two diagonally opposed nuts that hold the master cylinder to the booster, by 1/8 inch. Have an air ratchet ready to loosen the remaining two nuts quickly after the brakes have been applied and released.


From page 10 or 11
Two people will be needed to do this step
• Apply and release brakes, then quickly loosen primary brake line tube nut at the master cylinder
• The tube nut must be loosened quickly in case trapped pressure at the master cylinder bleeds down before the tube nut is loosened
Does fluid spurt out under pressure at the brake line tube nut?
No
Yes
• Tighten brake line tube nut to manufacturer's recommended torque
• Apply and release brakes, then quickly loosen secondary brake line tube nut
• Retighten tube nut
Two people will be needed for this step
• Tighten tube nuts to manufacturer's recommended torque
• Apply and release brakes
• Shut off engine
• After releasing brakes, quickly loosen the four nuts holding the master cylinder to booster, by 1/8 inch
• Quickly pull master cylinder away from booster, and quickly loosen primary brake line tube nut
• All of these steps must be done quickly in case trapped pressure at the master cylinder bleeds down before the tube nut is loosened
Does fluid spurt out under pressure at the brake line tube
Yes
No
The problem is probably with the ABS
Continued on next page

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Over Heated Brakes (continued)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Does fluid spurt out under pressure at the tube nut?
No
Yes
• The problem is probably with the booster or pedal linkage
• Retighten tube nuts
• Retighten 4 nuts to 34 to 41 Nm
The problem is probably with the master cylinder
Apply and release brakes, then quickly do the following:
• Remove pin that holds the pedal rod to the pedal arm
• Open primary tube nut at master cylinder
• These steps must be done quickly in case trapped pressure in the master cylinder bleeds down before the tube nut is loosened
Does fluid spurt out under pressure at the tube nut?
No
Yes
• Retighten the tube nut
• The problem is probably with the pedal linkage
• Retighten the tube nut
• The problem is probably with the booster

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Master Cylinder Cap Diaphragms

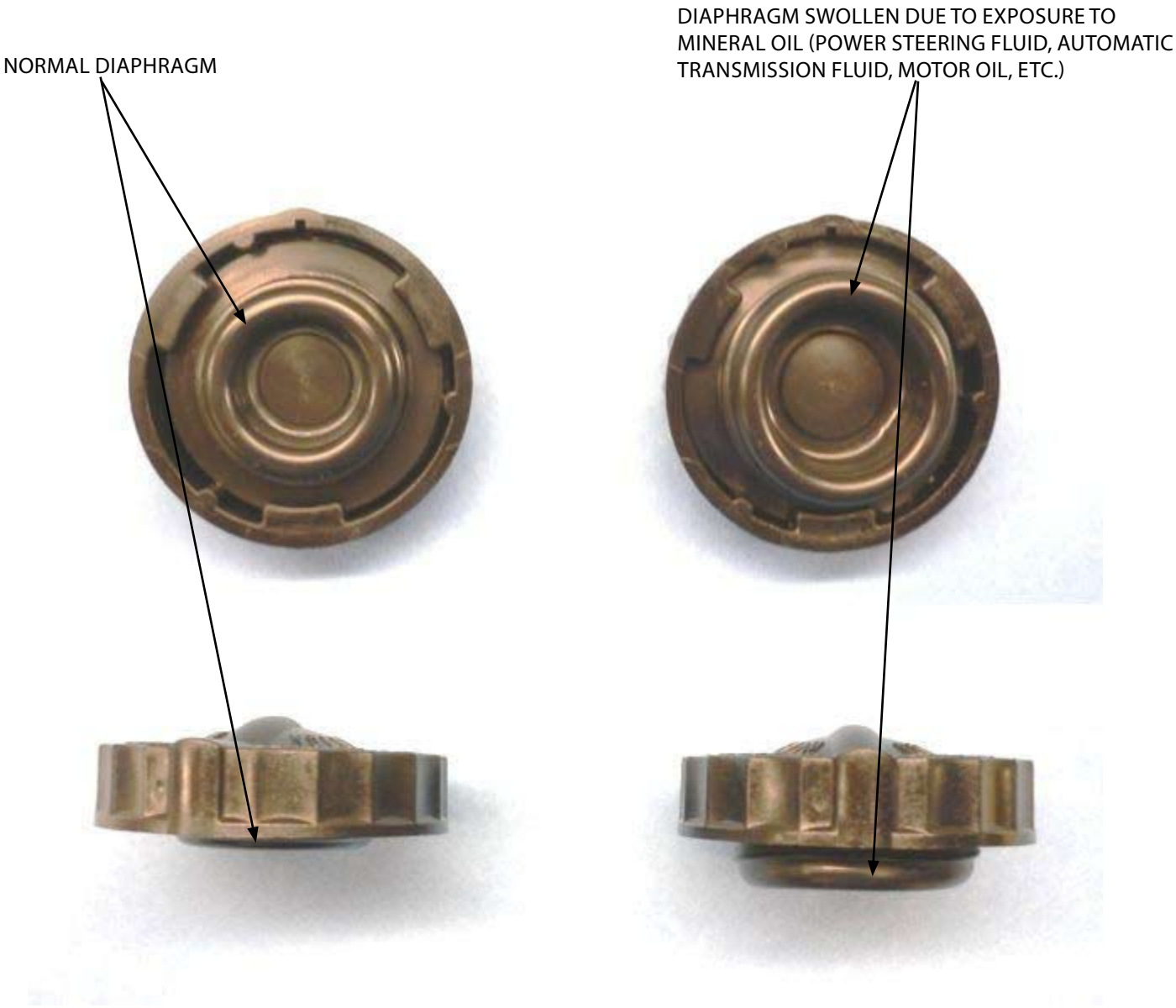
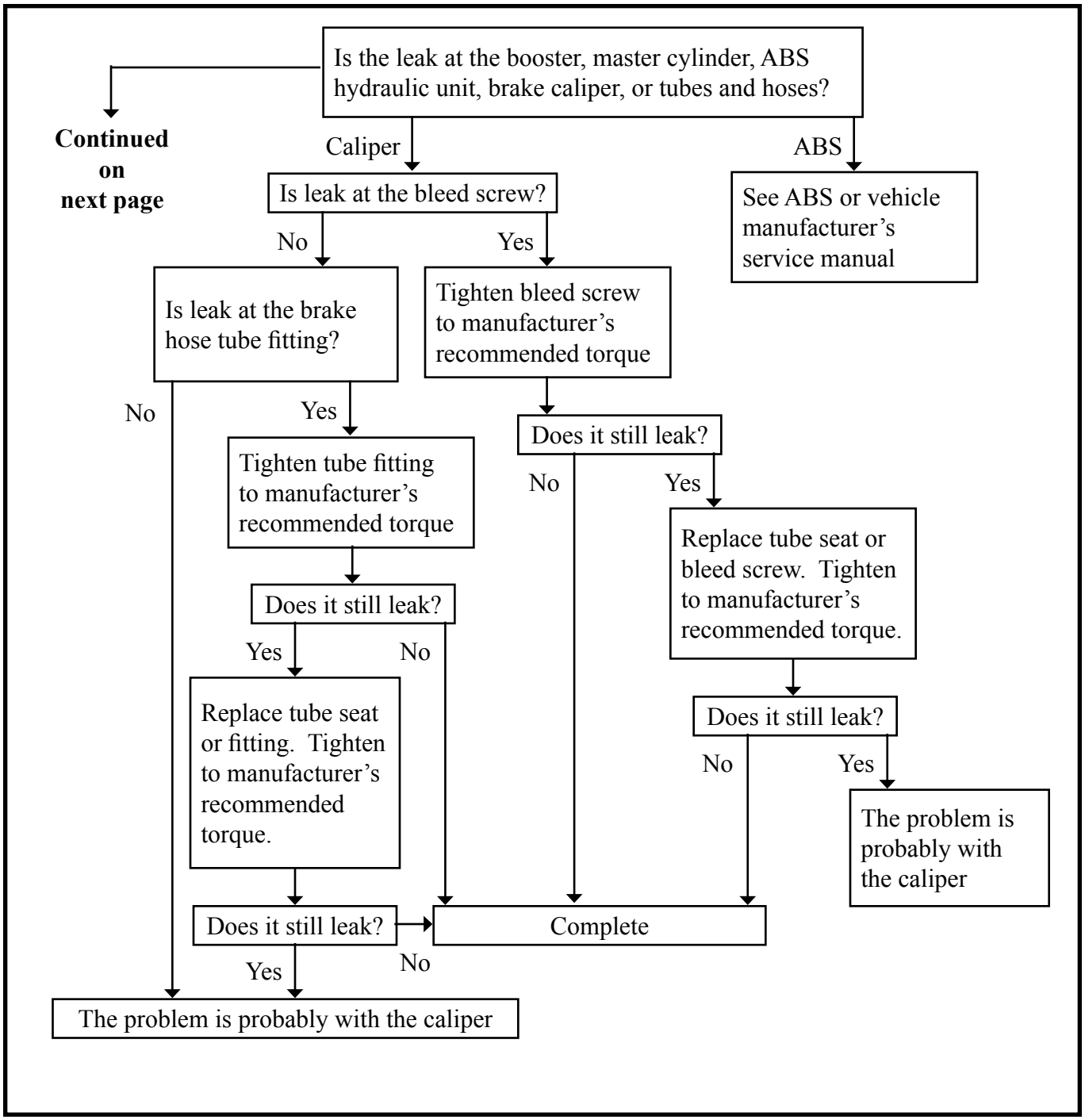

NORMAL DIAPHRAGM
DIAPHRAGM SWOLLEN DUE TO EXPOSURE TO MINERAL OIL (POWER STEERING FLUID, AUTOMATIC TRANSMISSION FLUID, MOTOR OIL, ETC.)

Figure 4. Comparison: Normal vs. Swollen Diaphragm

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Leakage

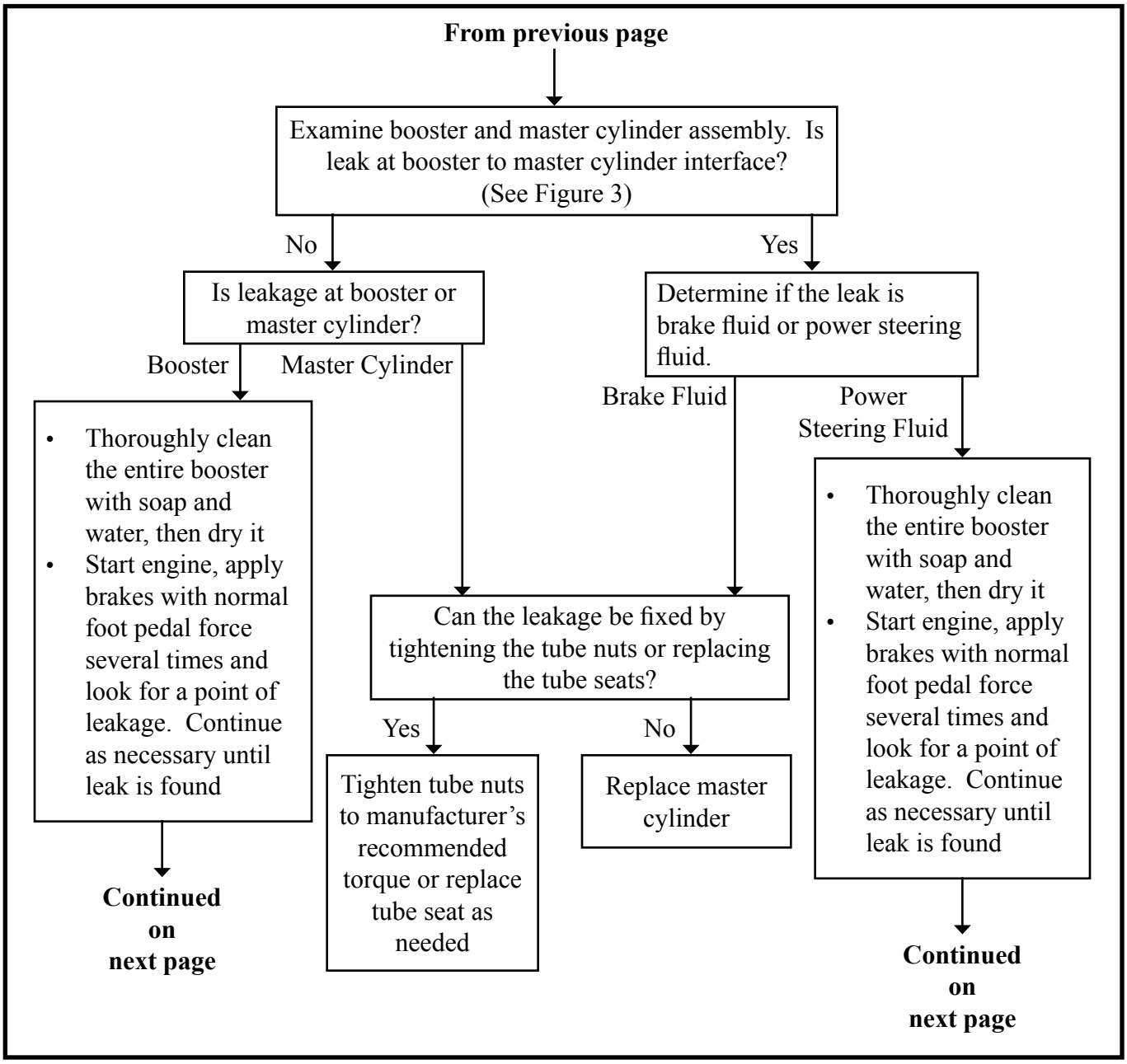
Most external leakage is easy to detect by wetness and/or appearance of fluid drops. However, slight dampness (no drops or wetness) may not indicate a leak.


Is the leak at the booster, master cylinder, ABS hydraulic unit, brake caliper, or tubes and hoses?
Continued on next page
Caliper
ABS
See ABS or vehicle manufacturer's service manual
Is leak at the bleed screw?
No
Yes
Is leak at the brake hose tube fitting?
Tighten bleed screw to manufacturer's recommended torque
No
Yes
Does it still leak?
Tighten tube fitting to manufacturer's recommended torque
No
Yes
Replace tube seat or bleed screw. Tighten to manufacturer's recommended torque.
Does it still leak?
Yes
No
Replace tube seat or fitting. Tighten to manufacturer's recommended torque.
Does it still leak?
No
Yes
The problem is probably with the caliper
Does it still leak?
Complete
Yes
No
The problem is probably with the caliper

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

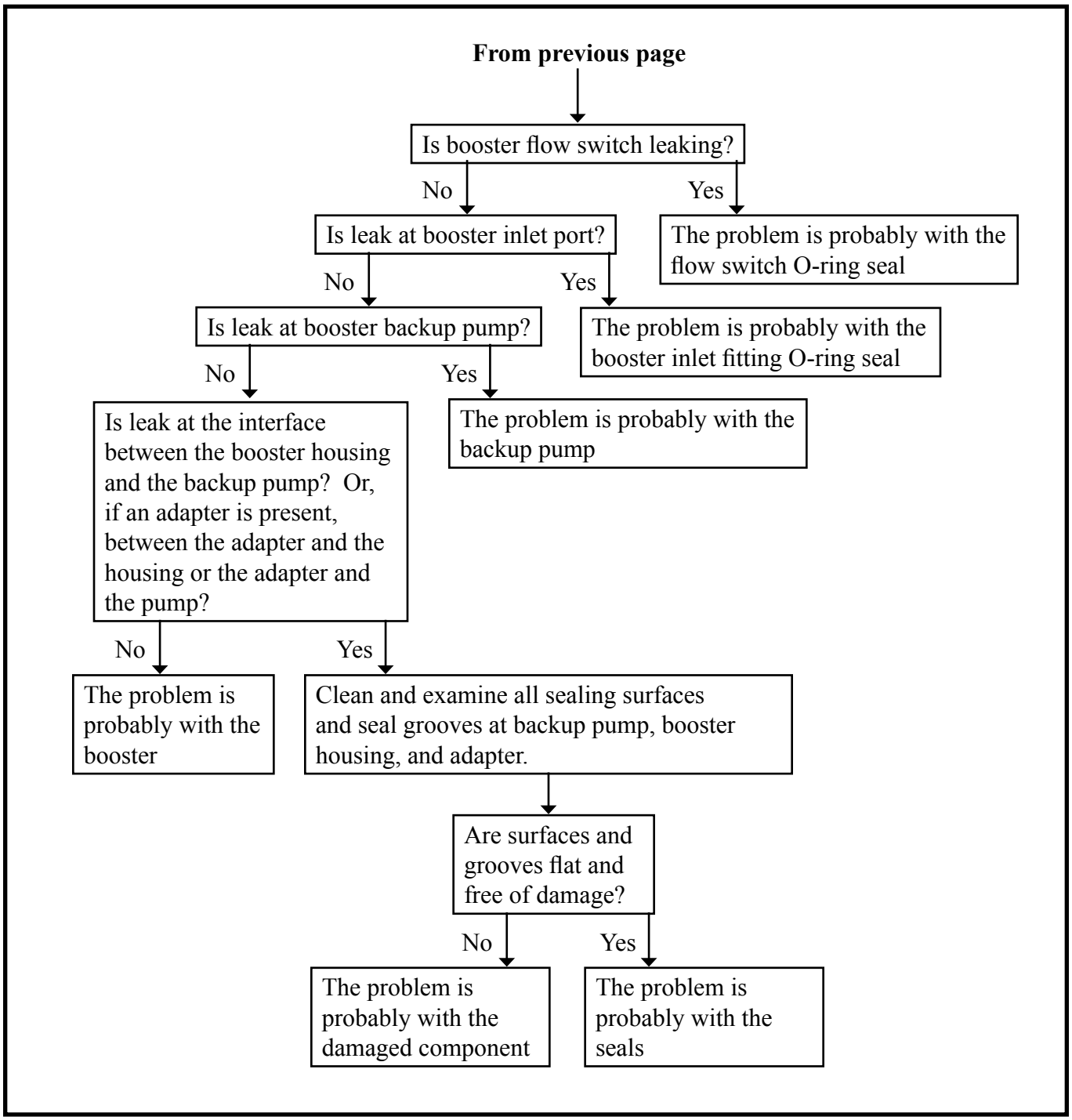
Leakage (continued)

Brake fluid mixes with water.
Power steering fluid floats on water.


From previous page
Examine booster and master cylinder assembly. Is leak at booster to master cylinder interface? (See Figure 3)
No
Yes
Is leakage at booster or master cylinder?
Booster
Master Cylinder
Determine if the leak is brake fluid or power steering fluid.
Brake Fluid
Power Steering Fluid
• Thoroughly clean the entire booster with soap and water, then dry it
• Start engine, apply brakes with normal foot pedal force several times and look for a point of leakage. Continue as necessary until leak is found
Continued on next page
Can the leakage be fixed by tightening the tube nuts or replacing the tube seats?
Yes
No
Tighten tube nuts to manufacturer's recommended torque or replace tube seat as needed
Replace master cylinder
• Thoroughly clean the entire booster with soap and water, then dry it
• Start engine, apply brakes with normal foot pedal force several times and look for a point of leakage. Continue as necessary until leak is found
Continued on next page

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Leakage (continued)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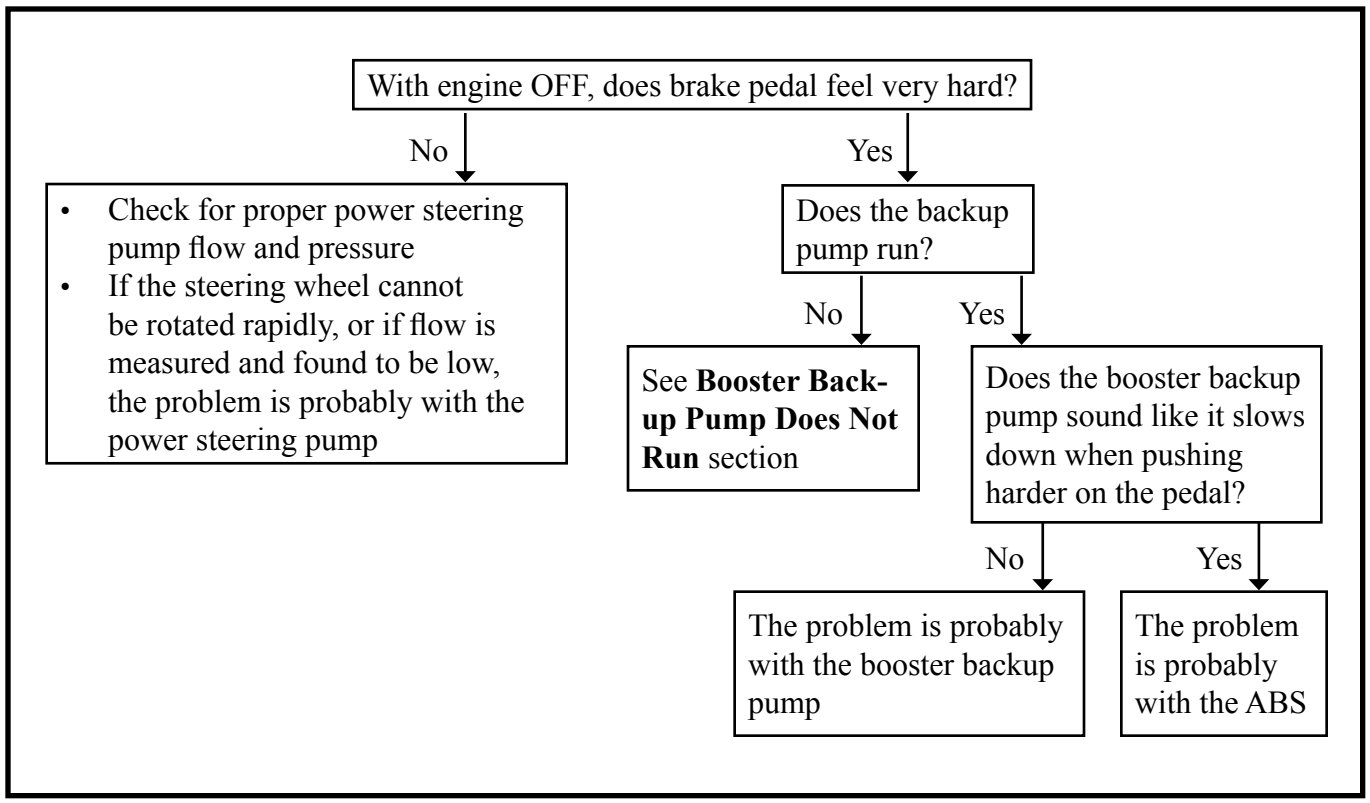
Is booster flow switch leaking?
No
Yes
The problem is probably with the flow switch O-ring seal
Is leak at booster inlet port?
No
Yes
The problem is probably with the booster inlet fitting O-ring seal
Is leak at booster backup pump?
No
Yes
The problem is probably with the backup pump
Is leak at the interface between the booster housing and the backup pump? Or, if an adapter is present, between the adapter and the housing or the adapter and the pump?
No
Yes
The problem is probably with the booster
Clean and examine all sealing surfaces and seal grooves at backup pump, booster housing, and adapter.
Are surfaces and grooves flat and free of damage?
No
Yes
The problem is probably with the damaged component
The problem is probably with the seals

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Brake Pedal Feels Very Hard

The most common reasons for a very hard brake pedal are:

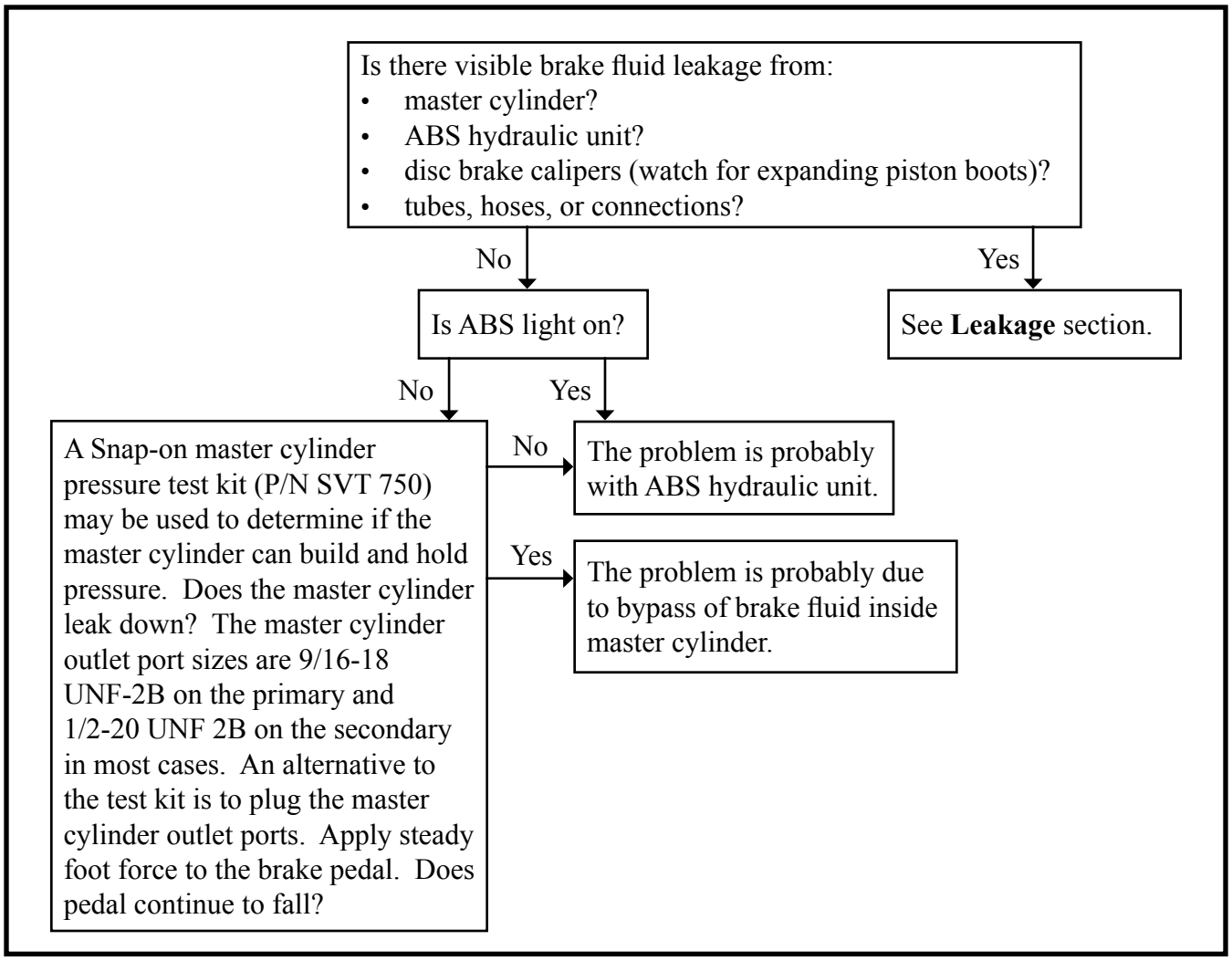
1) Insufficient flow or pressure from the power steering pump
2) The ABS hydraulic unit is blocking the flow of brake fluid to the calipers.
3) Binding pedal linkage - the brake pedal (lever) must be aligned side to side throughout full pedal travel, such that the booster pedal rod is aligned with the booster centerline to prevent linkage binding. With the pedal rod in the released position, the pin that attaches the booster pedal rod to the brake pedal (lever) should rotate freely by hand. Optimal performance occurs when the booster pedal rod articulates at the smallest angle possible.


With engine OFF, does brake pedal feel very hard?
No
Yes
• Check for proper power steering pump flow and pressure
• If the steering wheel cannot be rotated rapidly, or if flow is measured and found to be low, the problem is probably with the power steering pump
Does the backup pump run?
No
Yes
See **Booster Back-up Pump Does Not Run** section
Does the booster backup pump sound like it slows down when pushing harder on the pedal?
No
Yes
The problem is probably with the booster backup pump
The problem is probably with the ABS

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Brake Pedal Continues to Fall with Steady Foot Force

If no external leakage, the problem is due to bypassing fluid, either inside the master cylinder or inside the ABS hydraulic unit.


Is there visible brake fluid leakage from:
• master cylinder?
• ABS hydraulic unit?
• disc brake calipers (watch for expanding piston boots)?
• tubes, hoses, or connections?
No
Yes
Is ABS light on?
See **Leakage** section.
No
Yes
A Snap-on master cylinder pressure test kit (P/N SVT 750) may be used to determine if the master cylinder can build and hold pressure. Does the master cylinder leak down? The master cylinder outlet port sizes are 9/16-18 UNF-2B on the primary and 1/2-20 UNF 2B on the secondary in most cases. An alternative to the test kit is to plug the master cylinder outlet ports. Apply steady foot force to the brake pedal. Does pedal continue to fall?
No
The problem is probably with ABS hydraulic unit.
Yes
The problem is probably due to bypass of brake fluid inside master cylinder.

Brake Pedal Feels Spongy, Soft or Springy

If the brake pedal does NOT fall with steady foot pressure but feels spongy, soft or springy, the problem is probably caused by air trapped in the brake fluid system. Start by bleeding the brake system at the caliper furthest from the master cylinder and work from the back to the front of the vehicle.

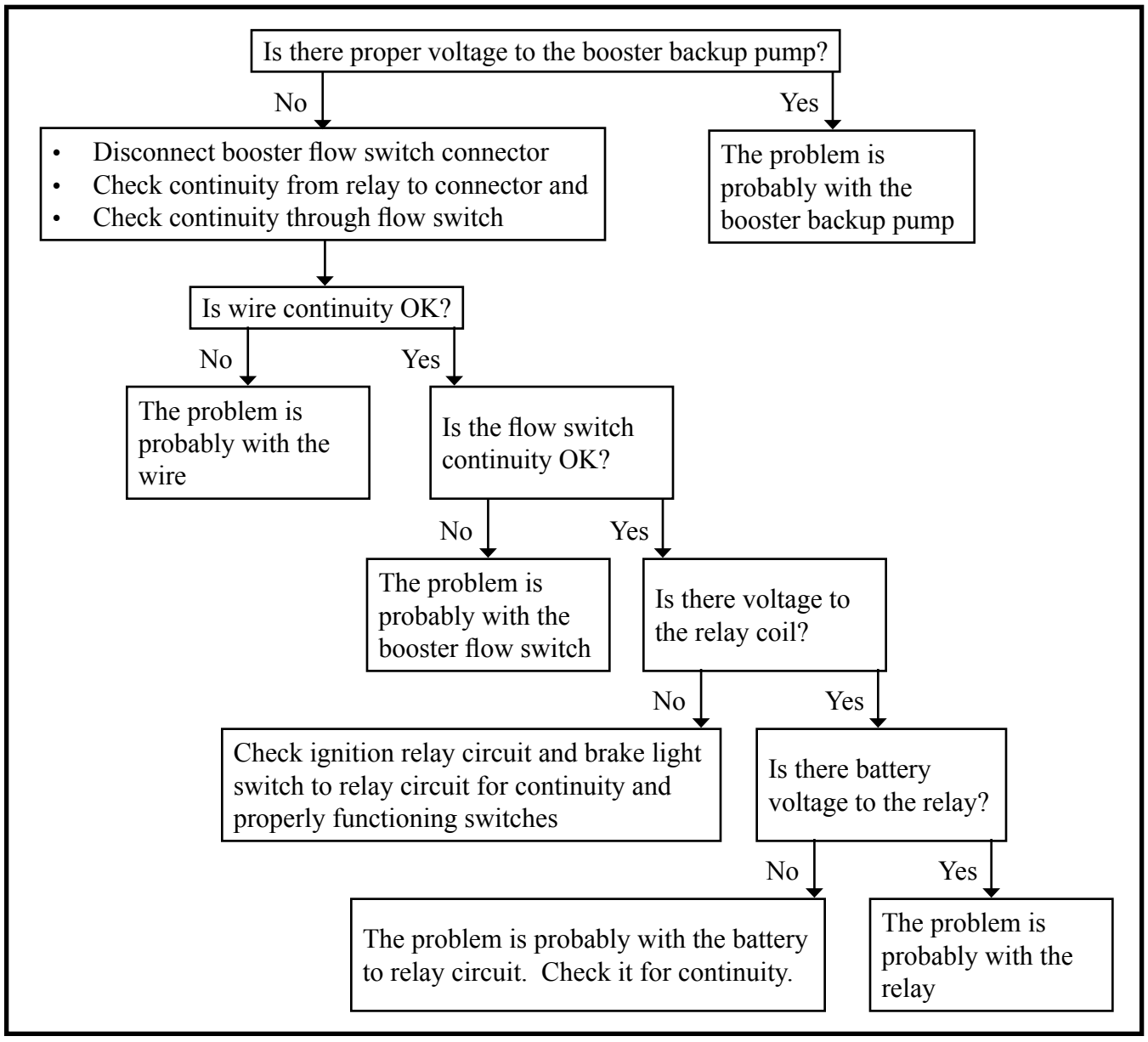
NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Booster Backup Pump Does Not Run

The booster backup pump will not run if there is no voltage to the motor or if the motor is damaged (e.g., burned out or jammed).

A no-voltage condition can occur because:

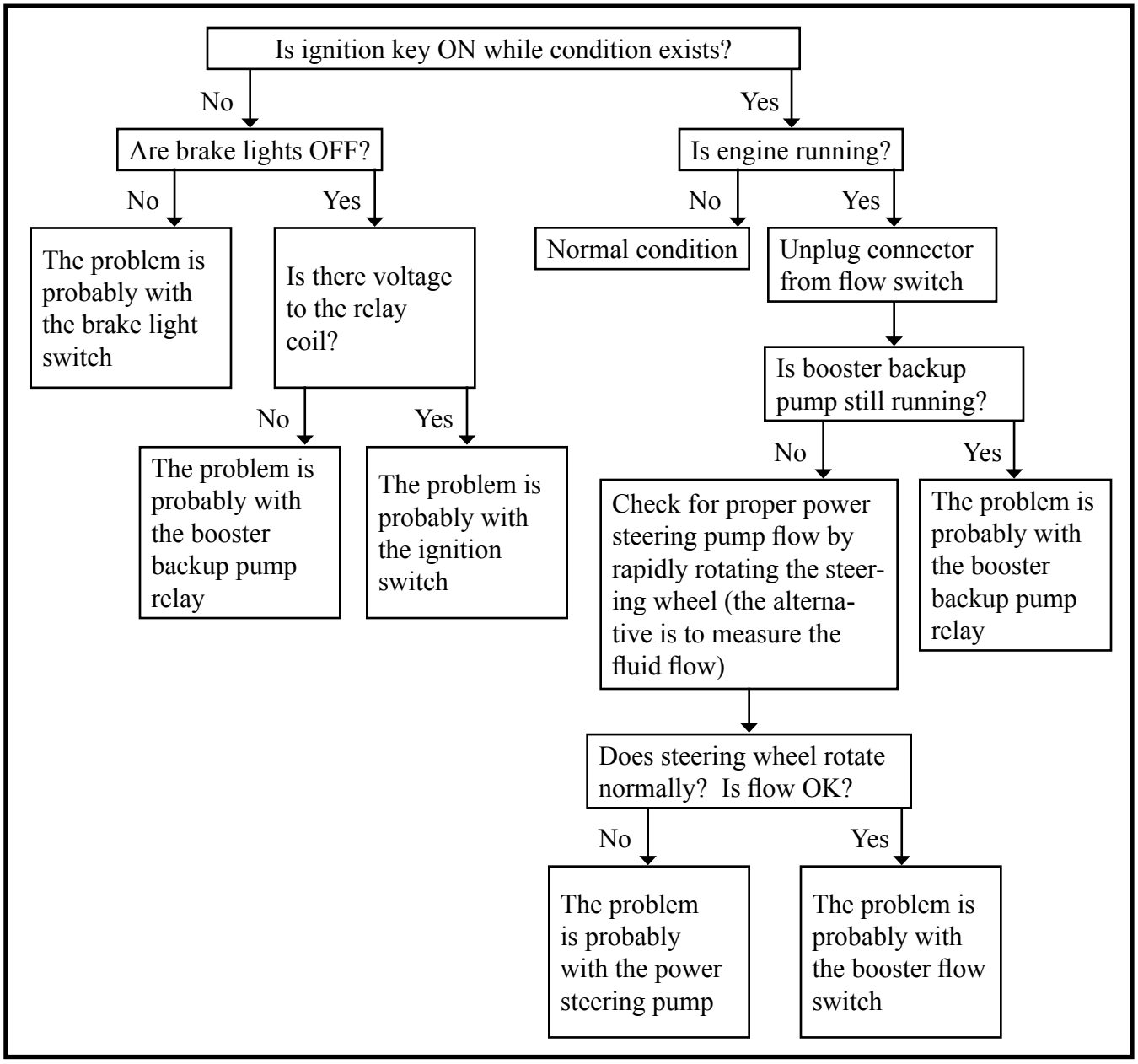
1) Battery is dead
2) Relay is stuck
3) Wires are broken (battery to motor circuit or ignition switch/brake light switch to booster flow switch circuit)
4) Booster flow switch is not closed to ground


Is there proper voltage to the booster backup pump?
No
Yes
• Disconnect booster flow switch connector
• Check continuity from relay to connector and
• Check continuity through flow switch
The problem is probably with the booster backup pump
Is wire continuity OK?
No
Yes
The problem is probably with the wire
Is the flow switch continuity OK?
No
Yes
The problem is probably with the booster flow switch
Is there voltage to the relay coil?
No
Yes
Check ignition relay circuit and brake light switch to relay circuit for continuity and properly functioning switches
Is there battery voltage to the relay?
No
Yes
The problem is probably with the battery to relay circuit. Check it for continuity.
The problem is probably with the relay

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Booster Backup Pump Runs Continuously

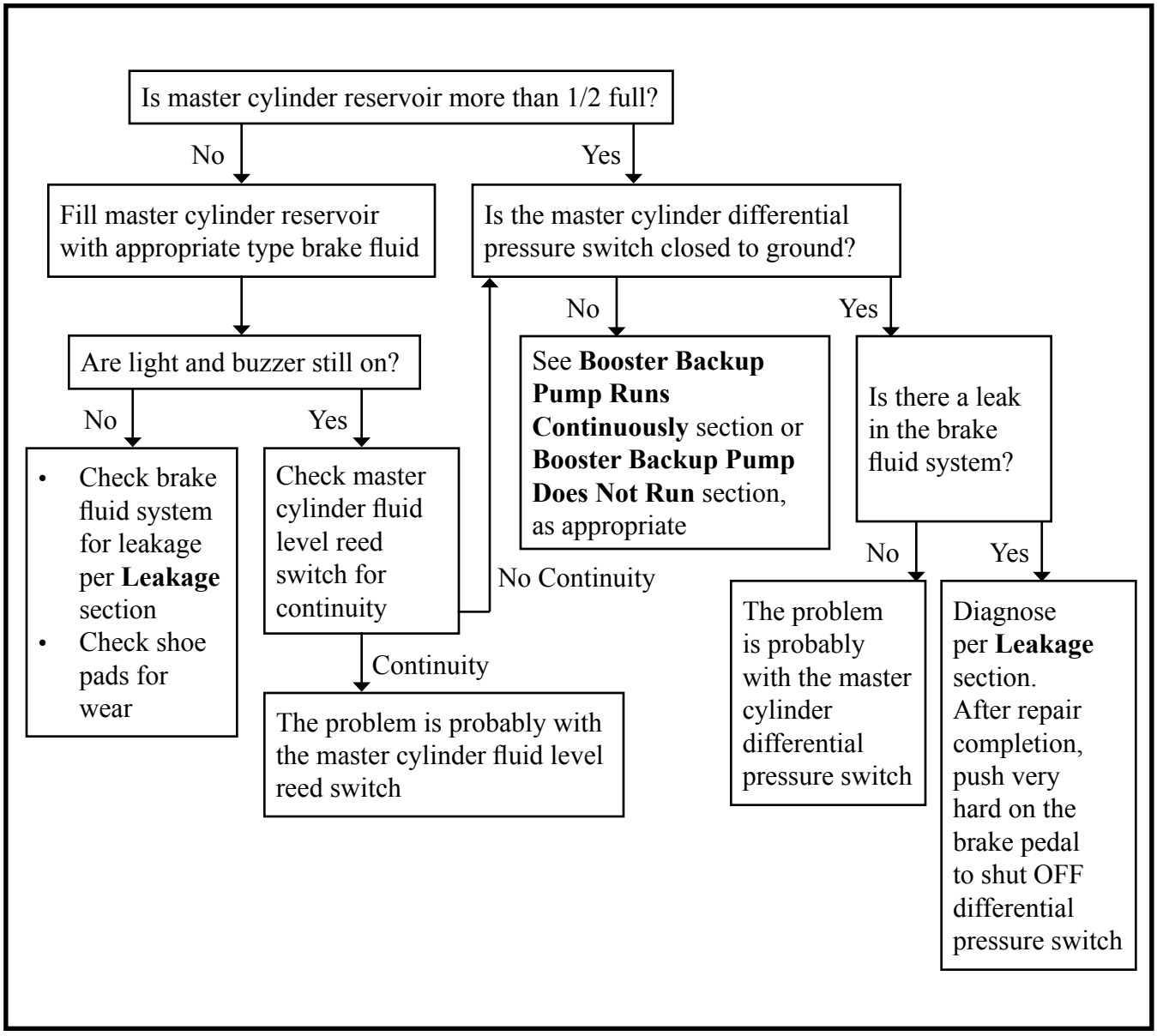
The booster backup pump can run only if the relay is closed. The relay will be closed only if:
1) The flow switch is closed and there is power to the coil, or
2) The relay is stuck closed.


Is ignition key ON while condition exists?
No
Yes
Are brake lights OFF?
Is engine running?
No
Yes
No
Yes
The problem is probably with the brake light switch
Is there voltage to the relay coil?
Normal condition
Unplug connector from flow switch
Is booster backup pump still running?
No
Yes
No
Yes
The problem is probably with the booster backup pump relay
The problem is probably with the ignition switch
Check for proper power steering pump flow by rapidly rotating the steering wheel (the alternative is to measure the fluid flow)
The problem is probably with the booster backup pump relay
Does steering wheel rotate normally? Is flow OK?
No
Yes
The problem is probably with the power steering pump
The problem is probably with the booster flow switch

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Brake Warning Light and Buzzer Do Not Shut off

The light and buzzer come on together, typically in response to signals from the parking brake switch, booster flow switch, master cylinder fluid level indicator switch, the master cylinder differential pressure switch or booster backup pump (see Figure 2).


Is master cylinder reservoir more than 1/2 full?
No
Yes
Fill master cylinder reservoir with appropriate type brake fluid
Is the master cylinder differential pressure switch closed to ground?
Are light and buzzer still on?
No
Yes
No
Yes
• Check brake fluid system for leakage per **Leakage** section
• Check shoe pads for wear
Check master cylinder fluid level reed switch for continuity
No Continuity
Continuity
The problem is probably with the master cylinder fluid level reed switch
See **Booster Backup Pump Runs Continuously** section or **Booster Backup Pump Does Not Run** section, as appropriate
Is there a leak in the brake fluid system?
No
Yes
The problem is probably with the master cylinder differential pressure switch
Diagnose per **Leakage** section. After repair completion, push very hard on the brake pedal to shut OFF differential pressure switch

NOTE: Use appropriate brake component and vehicle manufacturer's service manual for all repair work.

Correspondence concerning this manual should be addressed to:

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